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(54) Abstract Title
Variable thermal insulation material

(57) A variable thermal insulation material 1 having an inflatable layer comprising an envelope of vapour permeable "breathable" material, for example formed from a laminar arrangement of sheets of hydrophilic films 2a, 2b bonded to microporous substrates 3a, 3b adapted to define an inflatable volume 5. The volume 5 may be subdivided into an array of interconnected gas-linked compartments by means of members connecting opposing internal surfaces of the envelope thereby defining the inflated thickness of the material 1. An article of clothing may be made from the material 1 and include means to regulate the volume of gas within the breathable envelope.

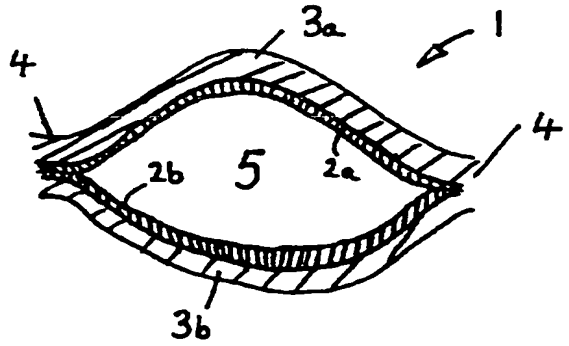


FIG 1

GB 2 323 015 A

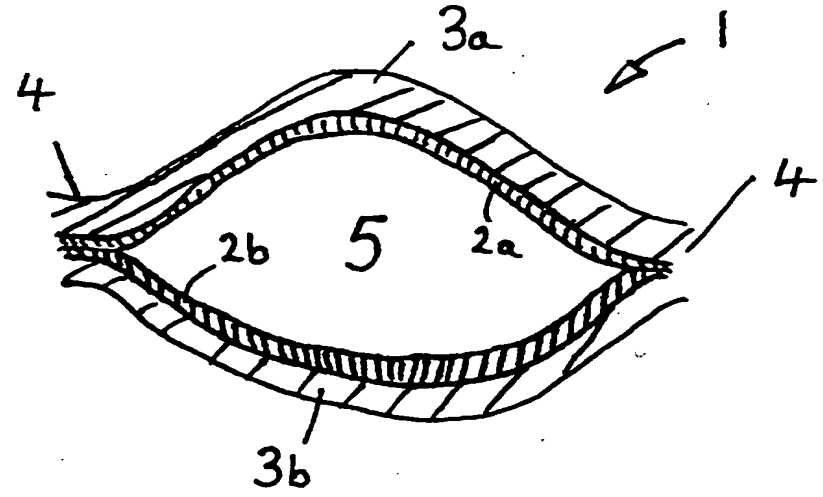


FIG 1

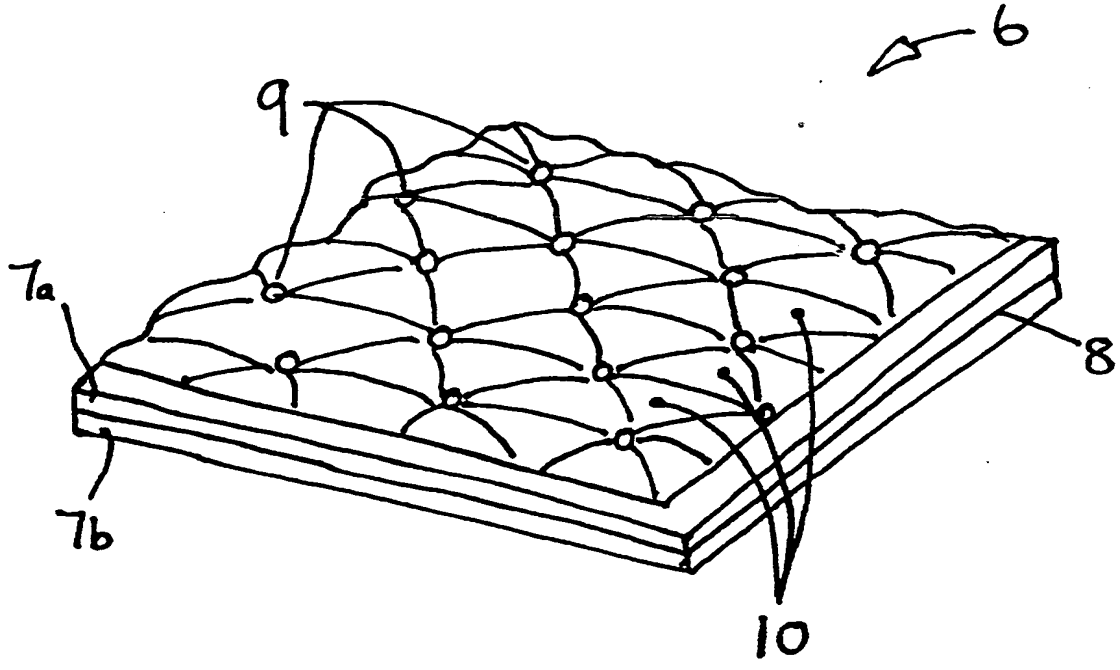


FIG 2

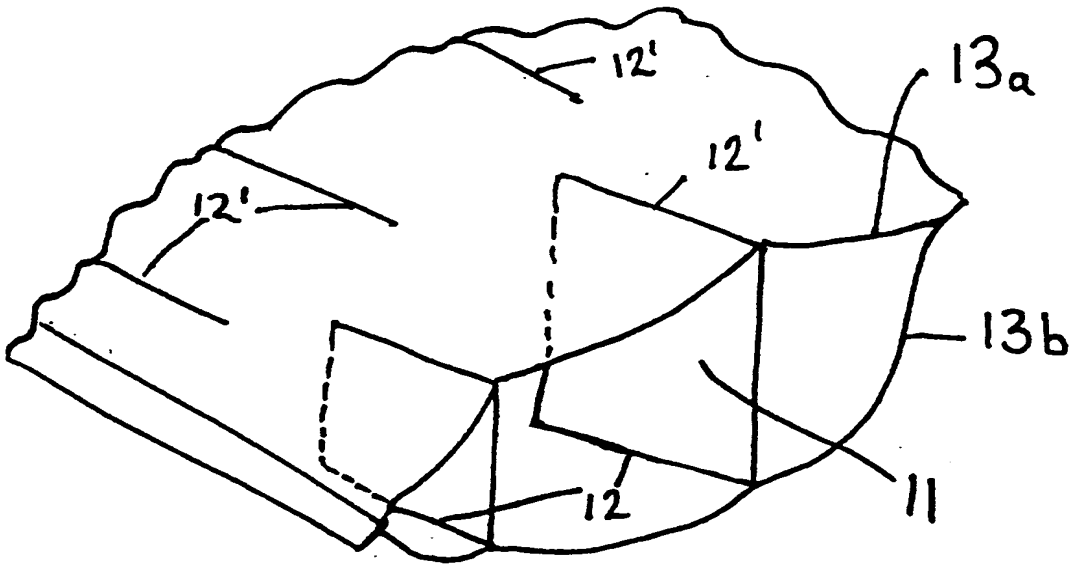


FIG 3

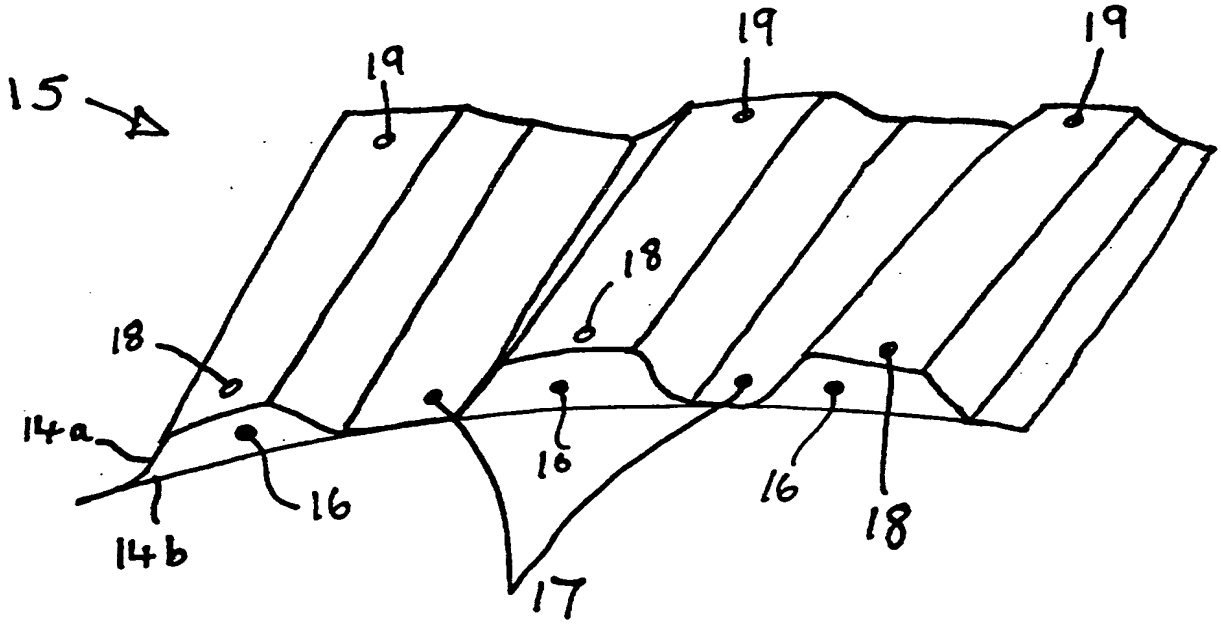
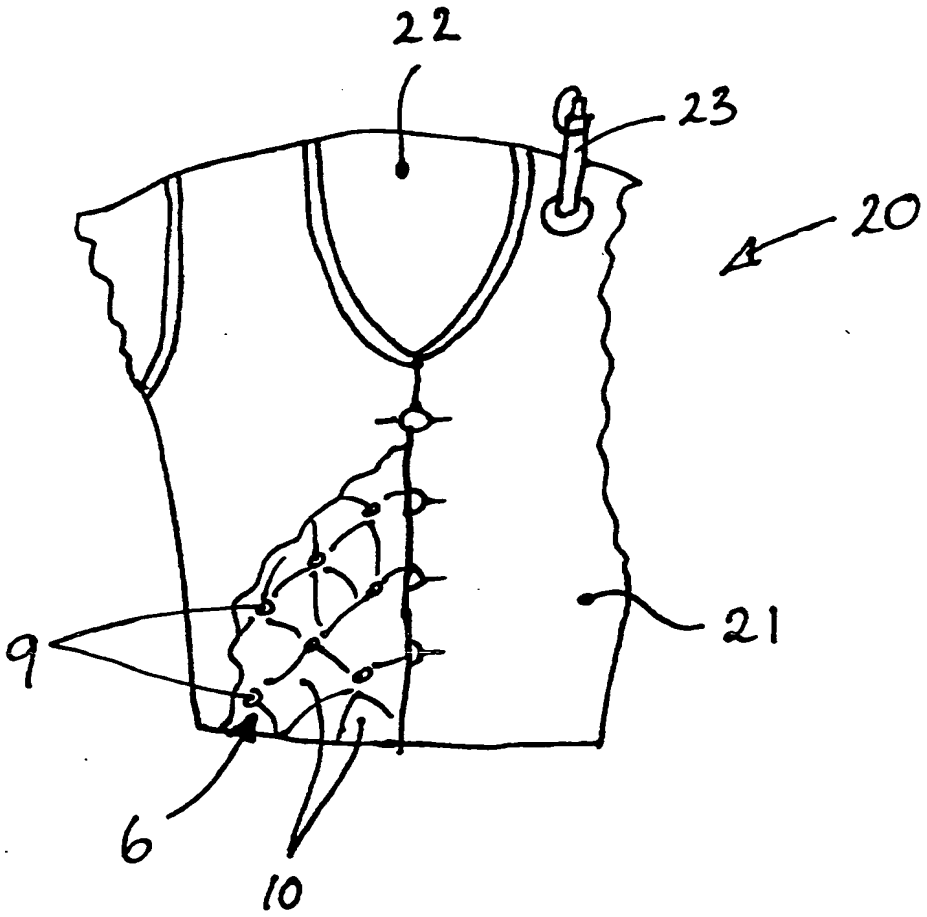


FIG 4

FIG 5



Variable Thermal Insulation Material

The present invention relates to a variable thermal insulation material and clothing made therefrom and in particular to a material, suitable for clothing, in which its thermal insulation properties can be varied by inflation or deflation thereof.

Such inflatable clothing is known and normally fabricated from a material comprising a non-porous envelope into which air or some other gas can be controllably introduced. However, being non-porous, the envelope is also impermeable to moisture. Thus, any perspiration generated by the wearer, for example during a period of physical activity, becomes trapped next to the wearers skin which may result in damp clothing, skin maceration or even hypothermia.

One known solution to this problem is disclosed in GB 2 242 609 B and is to provide a clothing material which comprises an inflatable layer having a plurality of interconnecting inflatable rubber tubes which, in their deflated state, define air spaces between adjacent sets of tubes through which water vapour may travel. On inflation, the tubes expand to close these spaces. This has the problem that any sweat generated when the thermal insulation is at a maximum (that is when the air spaces are closed) remains trapped next to the skin by the rubber until such time as the tubes are deflated.

Waterproof, water vapour permeable fabrics are well known to those skilled in the art of textiles and are often referred to as "breathable" fabrics or material. Breathable fabrics include those waterproof, water vapour permeable fabrics which comprise either or both micro-porous or hydrophilic materials. Micro-porous materials are made with pores the size of which are controlled to lie between that of water vapour molecules and that of water droplets (a difference of some 250,000 times) so that water vapour can pass easily through the material while water droplets cannot. Hydrophilic material is effectively non-porous and relies on its affinity with water molecules which are then transported through the material from the side of higher water vapour pressure to that of the lower pressure (which in most circumstances will mean away from the skin of a wearer).

According to a first aspect of the present invention there is provided a variable thermal insulation material having an inflatable layer wherein the layer comprises an envelope of breathable material adapted to define an inflatable volume. Such an envelope may be configured, for example, by hermetically sealing together two overlying breathable sheets about their periphery or by sealing a folded sheet about its open edge. This has the advantage that water vapour can pass from the body of a wearer of garments made using this material even when the envelope is inflated.

Advantageously, separation means, for example direct bonds formed between the opposing, internal faces of the envelope, may be included within the inflatable volume to provide an array of compartments joined by gas conduits. This has the advantage that transfer of gas between compartments is restricted so that the garment fabric can better maintain a generally uniform thickness when subjected to localised external pressure variations, for example due to normal movements of a wearer. A further advantage is that the flexibility of the garment fabric may be increased over a similarly sized fabric having only a single envelope since flexion can occur along the boundaries of the compartments formed by the separation means.

This arrangement can be simply realised by configuring the breathable envelope in an alternating array of bonded and non-bonded rows to provide a plurality of inflatable channels within the envelope. This arrangement has a further advantage that air can be trapped in channels formed between the non-bonded rows as these rows inflate to thereby increase the insulating effect of the garment fabric.

Most usefully the separation means may comprise collapsible baffle members provided within the envelope and made movable to an erect state upon inflation of the envelope, in which erect state the members help to hold apart adjacent faces of the envelope. These members can provide support for the breathable envelope to further resist deformation changes in its thickness.

Most preferably the breathable material includes a hydrophilic layer disposed on opposing sides of the envelope to enclose the inflatable volume. This may be achieved by employing only sheets of hydrophilic film as the envelope or coating a flexible substrate, which itself may be a micro-porous material, with a hydrophilic material.

Such combinations of micro-porous and hydrophilic materials are known, for example GORE-TEX® as available from W L Gore & Associates Inc of Elkton, Maryland, USA, in which the hydrophilic layer is used to prevent salt from sweat entering the pores which would otherwise reduce the efficiency of the micro-porous material.

The use of a hydrophilic breathable material, for example in the form of a sheet, film or coating, has the advantage that being effectively non-porous gas remain trapped within the inflatable volume for longer than might otherwise occur if a wholly micro-porous envelope was used.

Usefully, the hydrophilic breathable material is in the form of a hydrophilic film laminated to a water porous flexible substrate, such as a woven material or a micro-porous PTFE film The flexible substrate provides support for the film which can then be made relatively thin to improve transportation rates.

According to a second aspect of the present invention there is provided an article of clothing fabricated from this variable thermal insulation material according to the first aspect of the present invention, including a control means for regulating the volume of gas in the inflatable envelope.

Inflation and deflation of an article of clothing according to the second aspect of the present invention may be achieved using any of a number of well known means. For example the clothing may be connected to a supply of gas, which may be, for example, compressed air or frozen carbon dioxide, by supply means which also includes means whereby pressure in the clothing may be vented. Alternatively a simple hand pump or a "blow to inflate" arrangement, of the types commonly used in marine safety jackets may be employed in conjunction with a vent valve. Where the inflatable material comprises a plurality of compartments then most usefully the gas conduits may comprise an arrangement of one-way valves configured within the compartments to minimise air loss due to puncturing of any one compartment. This may be achieved, for example, by providing each compartment or group

of compartments with a one-way inlet valve and a one-way outlet valve to effectively isolate each compartment or group of compartments from the others. Manifold means may then be provided to link similar valves in order to facilitate the controlled variation of insulation.

Embodiments of the invention will now be described, by way of example only, with reference to the drawings of the accompanying figures, of which:

Figure 1 shows a sectional view of one embodiment of the variable insulation material according to the present invention.

Figure 2 shows a part perspective view of a "quilted" embodiment of the variable insulation material according to the present invention.

Figure 3 shows a sectional view of an embodiment of the present invention having internal baffle supports.

Figure 4 shows a sectional view of a "corrugated" embodiment of the present invention.

Figure 5 shows a schematic representation of an article of clothing according to the second aspect of the present invention.

Referring now to Figure 1, the variable insulation material 1 is shown in an inflated state and comprises two hydrophilic polyester films 2a, 2b laminated to sheets 3a, 3b of a micro-porous PTFE substrate. The laminar arrangement is hermetically sealed about its periphery, as shown generally at 4, to form an inflatable envelope in which there is provided an inflatable internal volume 5 between the two hydrophilic films 2a, 2b. The seal 4 can be made using any of a number of well known methods, including for example heat sealing, adhesive bonding or ultrasonic welding, selected for best performance with the materials used in the formation of the insulating material 1.

A refinement of this basic material is shown in Figure 2. The insulation material 6 is similar in construction to that of Figure 1 in that it is formed from two water permeable substrates 7a, 7b which can be chosen to exhibit the required physical or optical characteristics, eg being physically robust or camouflaged. Hydrophilic films 8 are laminated to the substrates 7a, 7b and the structure is hermetically sealed along their edges 4 to form an inflatable internal volume between the films 8. Additionally, separation means are provided

in the form of bonds 9 at a plurality of points over the material 6. These bonds 9 act to seal the films 8 together at these plurality of points, thereby forming a plurality of interconnected compartments 10 in a quilt-like structure. This quilt-like structure will act to limit the shrinkage in the peripheral dimensions of the material 6 on inflation.

An alternative separation arrangement is shown in Figure 3 in which the bonds 9 of the embodiment of Figure 2 are replaced with a plurality of elongate plastic baffles 11, each bonded along opposing long edges 12, 12' to the hydrophilic films 13a, 13b. Although the films 12a, 12b are sealed about their periphery they are sized so that relative lateral movement can occur during inflation and deflation of the envelope sufficient to permit the baffles 11 to move between a position in which they lie substantially parallel to the film and one in which they are substantially perpendicular and help hold the films 13a, 13b apart.

A further separation arrangement is shown in Figure 4 in which the two hydrophilic layers 14a and 14b are bonded together to form a "corrugated" material 15. This material 15 comprises an arrangement of inflatable compartments 16 alternating with rows 17 of bonded layers 14a, 14b. One-way valves 18, 19 are provided towards opposite ends of the compartments 16 and are configured to act as inlet and outlet valves respectively. In this way each inflatable compartment 16 is effectively isolated from any other so that if punctured only that channel will deflate. In use, the inflatable compartments 16 can be expanded to define channels 17 between them which may themselves be used to trap air and so add to the insulating properties of the material 15.

Referring now to Figure 5, an article of clothing, in the form of a coat 20 having a conventional outer covering 21 and a lining 22 selected having regard to the intended purpose of the coat. Sandwiched between the outer covering 21 and the lining 22 is an inflatable layer 6 of Figure 2, having a plurality of bonds 9 defining compartments 10. A blow valve 23, of conventional construction, is provided in the coat 18 for inflating and deflating the compartmentalised hydrophilic envelope. The valve 23 being positioned for easy access by a wearer's mouth.

It will be obvious to a person skilled in the art that clothing, such as shown in Figure 5 may be made employing the garment fabric as described in any of the embodiments described above.

It will also be obvious to a skilled person that many variations to the above described embodiments are possible in the light of the above teaching while still remaining within the scope of the invention. For example where separate films of hydrophilic material are laminated onto a substrate these could be replaced by films deposited, painted or sprayed onto suitable flexible substrate or where the hydrophilic film is described as being positioned on one or both of the internal surfaces of the inflatable volume similar benefits can be achieved by having it on one or both of the external surfaces. Moreover, although only described for use in the manufacture of apparel clearly the garment material may be used in other articles such as tents, sleeping bags or blankets, where variable thermal insulation is advantageous.

Claims

1. A variable thermal insulation material having an inflatable layer wherein the layer comprises an envelope of breathable material adapted to define an inflatable volume

2. A material as claimed in Claim 1 characterised in that it further comprises separation means adapted to configure the inflatable volume into an array of interconnected gas compartments.

3. A material as claimed in Claim 2 characterised in that the separation means comprises direct bonds between internal faces of the envelope.

4. A material as claimed in Claim 3 characterised in that the bonds are configured in spaced apart rows to provide a plurality of inflatable channels within the envelope.

5. A material as claimed in Claim 4 characterised in that each or a group of inflatable channels are provided with one way valves to act as inlets and outlets.

6. A material as claimed in Claim 3 characterised in that the bonds are configured in spaced apart points.

7. A material as claimed in Claim 2 characterised in that the separation means comprises a plurality of collapsible baffles each bonded along opposing edges to internal faces of the envelope and made movable to an erect state upon inflation of the envelope.

8. A material as claimed in Claim 7 characterised in that the collapsible baffles comprise elongate plastic members.

9. A material as claimed in any preceding claim wherein the breathable material comprises a hydrophilic layer enclosing the inflatable volume.

10. A material as claimed in Claim 9 wherein the hydrophilic layer is in the form of a coating deposited on to a flexible micro-porous substrate.

11. An article of clothing comprising a garment fabric as claimed in any preceding claim and control means capable of regulating the volume of gas within the inflatable volume of the breathable envelope.

The Patent Office

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Application No:	GB 9704824.3	**Examiner:**	Martin Holt Riley
Claims searched:	1-11	**Date of search:**	30 May 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A3V; A4G

Int Cl (Ed.6): A41D 13/00, 31/00; A47G 9/00, 9/02, 9/08

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	FR 2507064 A	(PASTORE) - see page 2, lines 12-27 and figure 4	-
A	US 5405370 A	(IRANI) - see column 3, lines 12-20 and figure 2	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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